SCIENCE

NEW YORK, APRIL 29, 1892.

THE NEW METHOD OF PROTECTING BUILDINGS FROM LIGHTNING.

IN this week's number we publish a letter on a case of lightning stroke, and would take occasion to suggest that it may help to clear up our ideas on these apparently erratic phenomena if we constantly bear in mind that the energy, just before a lightning flash, according to our present conceptions of electricity, exists in a more or less considerable mass of dielectric (the atmosphere and a portion of the earth), which includes the two points between which there is a difference of potential. In other words, if there is a difference of potential between a cloud and the earth the electrical energy exists diffused for the most part throughout a mass of air extending from the cloud to the earth, some, of course, existing in the surface layers of the earth. Now, when the flash takes place, all will agree that this energy manifests itself as light and heat, and in the knocking of things to pieces, perhaps.

We can but confuse our minds if we continue to think of the energy which causes the damage, or heat, or light, as coming from above or below, but should rather consider it as shrinking in, as it were, from all the circumambient dielectric to the places where it manifests itself as a heated line of air (the flash), or in the broken house-wall. The energy, which is what does the harm, comes, in the case of a vertical discharge not from above or below, but in the main horizontally. Do not let any one misunderstand me as saying that the electricity in such a case moves horizontally, for I do not. As I pointed out in my article in *Science* of April 8, I do not yet know of a case where the destruction, by the discharge, of a small conductor has failed to protect all else between two horizontal planes passing through the upper and lower ends of the dissipated conductor. It may be well to cite a few more cases of such protection resulting from the expenditure of the energy upon a small metallic conductor.

In the Philosophical Transactions, xlix., p. 298, is a paper read Dec. 18, 1755, by G. Brandir, Esq., descriptive of the striking of the Danish church in Wellclose Square, in which it is related that "on Monday, the 17th past, between six and seven o'clock, there was, among many others, one most amazing flash, accompanied with a clap of thunder, that equalled in report the largest cannon! That the next morning, observing the church clock to be silent, they went to the belfry, and found the wire and chain, that communicated from the clock in the belfry to the clapper in the turret, where the bells hang, to be melted; and that the small bar of iron from the clock, that gives motion to the chain and wire, just where the chain was fastened, was melted half through, the bar being about three-fourths of an inch broad, and half an inch thick. Several links of the chain, and of the wire, I have now the honor to shew you, where it will be observed, that the lightning took effect only in the joints. But whether it entered by communication from the wire exposed to the air in the small turret, through the roof of the belfry, or at the windows, there being several panes broke in the south and west corners, I cannot say; although I presume rather the first way, as it is very possible, that the bare report of the thunder might have occasioned the latter.

"The pieces of the wire and chain were scattered over the whole belfry, nor could it be discerned, that the wood-work, or aught else, had suffered."

There is a case cited in all the books on lightning, which is also interesting in this connection. The packet ship "New York" was struck by lightning April 19, 1827, while in the Gulf Stream. She was provided with a lightning rod, if it may be so called, consisting of a pointed iron rod one-half an inch in diameter and four feet long, at her mast-head, from which extended an iron chain, 130 feet long, to the sea. The links are described as one-quarter of an inch in diameter, whatever this may mean. It is evident, however, that the chain was not a heavy one and that, being a chain, it was a conductor of variable resistance, a condition well known to be conducive to destruction in case of the passage of a high-potential current. The rod was struck. A few inches of the terminal were melted, and of the chain all except three feet was dispersed. The important fact here as always, so far as yet known, is that no damage was done to the ship by the lightning.

My method of protecting buildings from lightning consists simply in placing on the building, from its highest to its lowest part, a small conductor of variable resistance, so as to make sure of its destruction in case the house is struck. And I base my confidence in its success on the fact that, exercising all possible diligence in the search through the records of actual cases of lightning stroke, I have not met with a case of failure of such a conductor to protect, when by accident it has been employed; and, further, I have failed to elicit any exceptions by the numerous methods of publication I have employed.

I employ one or two pounds of copper on a house of the ordinary size, and if anyone will take the trouble to calculate, according to the best data at our disposal, the energy dissipated in the evaporation of a pound of copper, he will understand how it is that there is none left to do further damage.

Another point which the records bring out, and which has been noted by others, is that damage occurs near large masses of metal. The small masses of metal, if not in confined spaces, burn as harmlessly as gunpowder on a sheeet of paper.

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SPANIARDS are making a good many preparations for the celebration of the four-hundredth anniversary of the discovery of the the New World. In the autumn of the present year, says *Nature*, there will be several exhibitions, in one of which will be shown objects relating to the continent of America before the advent of Europeans, while another will illustrate the state of civilization in the colonizing countries of the Old World at the time when the new continent was discovered. In October the Congress of Americanists will meet at Huelva, and will discuss a variety of subjects relating to the continent of America and its inhabitants 400 years ago. In the same month, at Madrid, a Spanish Portuguese-American Geographical Congress will meet for the discussion of such questions as relate more particularly to the "Iberian-American" races, their aptitude for colonization, and the future of the Spanish language.

COLLECTING GORILLA BRAINS.

AT A recent meeting of the Academy of Natural Sciences of Philadelphia, Dr. Henry C. Chapman described three gorilla brains collected by the Rev. R. H. Nassau, D.D., in 1890, upon the Ogove River, West Africa. The brains have heen presented by him, through Dr. Thos. G. Morton, to the academy. Dr. Chapman's observations upon these brains are embodied in a paper now in the course of publication in the Academy's Proceedings. At the close of Dr. Chapman's communication, Dr. Nassau related his experiences when obtaining the brains. The appended extracts are from two letters written by him to Dr. Morton in 1890, in which he tells the story of the two expeditions he made to obtain them. The extracts have been made by the kind permission of these gentlemen. JAS. E. IVES.

TALAGUGA, OGOVE RIVER,
GABOON AND CORSICO MISSION,
WEST AFRICA, MARCH 7, 1890.

I made all plans with great forethought as to details; the season would be cool and dry, when I could hunt with less discomfort; no flooded low grounds; a large proportion of the leaves fall in the dry season, leaving the thickets less dense and giving better chance for spying animals. There are scarcely any gorillas in this Talaguga region; I have known of but two being killed during the eight years I have been here. So I closed my house and went down the seventy miles to Kângwe. There I chose a good crew of eight young men. Four carboys of chloride of zinc had been carefully kept all these years; I took a jugful of it. Not to waste my alcohol (in which was to be immersed the brain as it should finally go to you), I took along several gallons of rum. . . . Proper receptacles were taken for receiving the brains. I took my Winchester and double-barrelled gun (suitable for either shot or bullet), and invited with me one of our French associates, M. Gacon, a Swiss sharpshooter, who had the latest Swiss army breach-loading rifle. For the native hunters I took two of the best (very poor at best) flint-lock muskets from the Trading House, good for two weeks, etc.

From this point I will copy from my diary written at the time.

"Wednesday, July 17, 1889. Rose early and by 9 A.M. were at our destination. M. Gacon, after our noon meal, impatiently went out to hunt with Ogula. They returned having seen signs of gorillas, but not having seen the animals themselves. A council was held in the evening with the villagers as to time, routes and the art of hunting a gorilla. Everybody was sure I should not be in the village four days without succeeding; they told wonderful stories of the numbers and audacity of the gorillas, that not two days passed but that somebody saw them in the gardens. As the garden work is done principally by women, it was they who most frequently saw them, sometimes actually meeting them in the path and being pursued by males. From all their accounts the gorilla is full of the arts and tricks of the monkey tribe, quick to read faces. The women being unarmed and afraid, the animals were more daring to them than to men. But they all said that we white people would have no chance of getting so near, that the animils would detect our strange odor and fear our white faces. They hoped we would kill many, for their gardens were devastated by gorillas, pigs, oxen and elephants. Most of the men said that though they often saw these animals, they were afraid to shoot with their flint-locks that often uncertainly flashed in the pan or whose slug-shots were not immediately fatal; that then they were at the mercy of the wounded beasts. They warned us, if we met with a male gorilla who dared to face us, not to fire till only a few yards distant, and, even then, not to aim at the head, for the animal had the art, being acquainted with guns, and all have informed each other (so the natives believe), of ducking down its head at the click of the trigger. We were to aim at the abdomen, which from its size could not fail to be injured, and the head or chest would probably be pierced by the animal's having ducked its head down to dodge a shot aimed, as it supposed, at its head.

"Thursday, July 18. We all went, some fourteen men and eight dogs, in the boat to a large island shortly after sunrise. My own crew of six were afraid and I left them in the boat, and Ogula described the lie of the land so that they were to follow around to another part where we should probably emerge. The rest of us entered the thicket, very dense; it grows up so wherever there are abandoned plantations. The original forest is easily threaded, for the dense foliage of the tall trees kills out by its shade the underbrush. But the gorillas are looked for mostly in the plantations, old and new. But after four hours of search nothing was heard or even seen except the tracks of the wild pigs. In the afternoon Okendo, whose plantation was on another part of the island we had been at, came in frantic haste saying a gorilla was just seen by his wife. We went. Sure enough, there were the pieces of sugar-cane the beast had chewed and spat from his mouth, still wet with spittle, and the broken branches of cassava marked his exit from the garden. We divided into three companies, to the right and left and centre. I was in the centre with Osamwamani. M. Gacon went with Ogula to the right. Ogula was the only one who saw the gorilla, a female; but it disappeared before he could draw on it. This stimulated our plans that night for the next day's work.

"Friday, July 19. M. Gacon started in a canoe with three men at 5 A.M., and I followed an hour later in the boat with my crew and four men, the crew as usual awaiting us in the boat. We went in the general region of the previous afternoon; there were frequent and fresh signs, dung still warm. The thicket was impossible to be passed by a human being in any other than the too noisy way of cutting with the long knives we carried, or by crawling on our bellies under the mass. The mass of vines, bushes and, worst of all, a grass growing many yards in length whose long, narrow leaves were, on their edges, as sharp as knives. The density of this growth above killed out the leaves lower down, and the thicket was tunnelled with many passages, intersecting and opening out into spaces of a square rod or two where might be a clump of trees, and where the animals had their sleeping places on the lower branches. You perceive that even if a gorilla was heard or sighted in such a thicket while we were crawling on our bellies, it could get away before we could snatch our gun into position, and, if the animal should only be wounded, we should be in a very ugly place for defending ourselves. The trail became so hot we were sure the animal was near. We divided, M. Gacon going with Ogula to one side and I and Osamwamani to the other. Suddenly we heard the dog Hector barking sharply, and shortly after the screams of a baby gorilla. The noises did not seem to be more than forty or fifty feet from us; we could *see* nothing. The barking became more savage, the screams more agonized, and, as we tore our way through the thicket, there was added the angry howl of a

parent gorilla. Everybody took his own way, losing sight of each other, following the sounds, along our several radii, to the fierce centre. But the bark ceased with a yelp; the screams and howl rapidly receded, faster than we could follow. I emerged into a small open glade, where stood Ogula, M. Gacon and Hector. The dog had come upon a mother and child at the foot of a tree in a hollow, which was still warm. The mother had fled at first sight, but had returned at the screams of the child, which the dog had seized. It was just at this moment that M. Gacon and Ogula saw them. The mother slapped the dog with her hand and the dog dropped the child with a yelp of pain. Ogula allowed the precious moment to pass, fearing to kill the dog with the slugs of his musket. M. Gacon was in his rear and emerged on the scene just as the mother, who had picked up her child, disappeared. He had not a moment's time to get his rifle into position. On our way back to the boat we came to a large glade, where evidently there must have slept that very night not less than twenty gorillas. It was exasperating that we had been only a few hundred yards from that spot the afternoon before and that very morning. All our hands and faces were cut and bleeding by the fearful grass in that frantic rush, and I had hurt my knee by a fall over a log. So we rested and mended ourselves during the afternoon in the village.

"Saturday, July 20. We all rose at three A.M., and, volunteers and all, went to a new place, where on the previous day a large male gorilla had been reported. I did not like the plan, I wanted to go to yesterday morning's region; but Ogula was overpersuaded by the volunteers. Their plan was to form a line across the long point on which the animal had been heard on the previous afternoon. We entered the forest in the dark of the morning. I am not accustomed to such exhausting work before breakfast, and when, after a fruitless search, we emerged again, I was provoked to find that three old volunteers had changed their minds, had not followed us, and were resting comfortably on the sandy beach munching peanuts.

"Monday, July 22. M. Gacon went out with the hunters to a new place, where a gorilla had been heard on Sabbath, but they returned fruitless; M. Gacon had shot a flying squirrel. He went out again in the afternoon alone, but saw nothing.

"Tuesday, July 23. Ogula and Osamwamani, ashamed over our ill-success, declared I should have a gorilla that very day, and went without us before daylight to a distant place. They returned in the evening having seen many gorillas, some of which had taken refuge in high tree-tops beyond the range of their muskets. They regretted not having taken us along. We gave up the search for a gorilla. My knee was still inflamed and M. Gacon's enthusiasm waned. We could not deny that there were gorillas in abundance, but the difficulties in obtaining them were just as obvious"

During all these years from 1882 to 1889, while I was prevented from hunting myself, I had employed a hunter, Azâze, living at Orânga, about 35 or 40 miles down the river from Kângwe, promising him a good reward if he brought me a dead gorilla in good condition. To get it to me in good condition at Kângwe he would have to start immediately and pull day and night. He brought two carcasses here while I was away at Talaguga some years ago, and they were lost, there being no one here to open a skull carefully. He sent a third, a small one, just a year ago. It reached me here just as I was starting up to Talaguga. I had actually stepped into the boat and in five minutes should have started. The messenger had arrived during the night, but had taken his leisure to deliver it. I would have stopped the journey, but the carcass was then spoiled, and what I would have given a large sum for twenty-four hours earlier I threw into the river as worth nothing. His last effort was eight months ago, the week before I went on the hunt to the lake. It was a very large old male. Azâze had made a desperate effort to reach here with it safe. He arrived on a Sabbath noon. I did not go to the water-side to see it, my principles would not allow me to work on it on the Sabbath; but early Monday A.M. I got the brain out, but it was then too soft.

KANGWE MISSION STATION, OGOVE RIVER,
WEST AFRICA, October, 2, 1890.

This year in July I went again to another part of the same lake, Kângwe, and hired two native Bakele hunters. They saw in two days' hunting both elephants and gorillas, but failed to kill any. But some Galwa young men, knowing my errand, went out on their own account and found five gorillas, an old male, three females, and a stout grown lad. The place was in sight and gun-sound of the village where I was waiting across one of the beautiful bays of the lake. The females fled; the old male showed some fight, but fled when the lad was shot. The carcass was brought to me still warm. I had a carpenter's back-saw and a chisel, I worked with care; but in my anxiety at the last I gave an unfortunate blow or two and wounded the brain, and much of it exuded under the astringing influence of the chloride of zinc; also, I had no alcohol and had to use trade rum, and I fear that the brain has not been kept by it from decay. A few days later, I by a very, very rare chance bought two gorilla male children; they were in good condition and tamed. The servant in whose care I left them at this place, Kângwe, during a few days' absence neglected them and they were attacked by "driver" ants the night of the day before my return. One survived twelve and the other forty-eight hours. Their cries for help had been disregarded, and when I discovered them they could only moan. I combed thousands of ants off of them. That servant of mine had also neglected to feed them, and they were partly starved before the ants attacked them. The second of these I finally killed, seeing it was dying; and, working very carefully with the chisel, using no mallet, loosened the brain without injuring the membranes. I was afraid to work down toward the base of the brain, so I left it adhering and sawed away the face so as to make the mass small enough to enter the jar. I enveloped it and also the first brain in separate muslin bags so that they should not abrade each other.

That attack by driver ants was made at this house, Kângwe; and one of the little fellows, the one that I finally killed, was still living next day when I started up river by my boat to my Talaguga home, 70 miles, a four days' journey. It died at night at my first camp on a sand-bar in the river, and I did the work at midnight by torch-light. I put the brain in the chloride, and on arrival at my house three days later, put it into rum. R. H. NASSAU.

NOTES AND NEWS.

IN connection with the celebration of the fourth centenary of the discovery of America by Columbus, the Italian Botanical Society, says *Nature*, invites the attendance of botanists of all countries at a Botanical International Congress, to be held at Genoa, from the 4th to the 11th of September. In addition to the meeting for scientific purposes, there will be excursions on the shores of the Mediterranean and in the Maritime Alps; and during the same time will also take place the inauguration of the

new Botanical Institute built and presented to the University of Genoa by the munificence of Mr. Thomas Hanbury, of La Mortola, and the opening of an Exhibition of Horticulture. All communications should be addressed to Professor Penzig of the University of Genoa.

—In the Annual Report for 1892 of the Berlin branch of the German Meteorological Society, Professor G. Hellmann gives an account of his continued experiments, which are summarized in *Nature*, on the effects of exposure on rainfall records, and on the determination of the distance apart that rain-gauges should be erected in order to obtain an accurate account of the rainfall of any district. Simple as the question appears, the experiments, which have been carried on for seven years, have not sufficed to give a definite answer. Very considerable differences are found in the amounts recorded at stations comparatively close to each other. This result is partly owing to the effect of wind, especially in the case of snow. The following are the most important conclusions derived from the experiments: (1) The more a rain-gauge is exposed to the wind, under otherwise similar circumstances, the less rainfall it records, and the higher a gauge is placed above the ground, the less rain it catches, as the disturbing influence of the wind is greater than on the surface of the ground. But if protected from the wind, a gauge will give useful results in an elevated position. The usual instructions to erect the gauge as openly as possible are therefore incorrect. (2) Even in a flat country, differences of 5 per cent occur in different months, at stations a quarter of a mile apart; in stormy weather, especially during thunderstorms, the difference may amount to 100 per cent. The amounts recorded at neighboring stations agree better together in spring and autumn, and also in relatively wet years. Further experiments are needed, if possible by means of anemometers erected at the same level as the rain-gauges, to determine more accurately the effect of wind on both rainfall and snow.

— At a meeting of the Engineers' Club of Philadelphia, April 2, Mr. W. S. Auchincloss read a paper on Yearly Tides. In this paper the author stated that he proposed to show that confined bodies of fresh water are subject to yearly tides of greater or less magnitude, depending upon the nature of the basin or upon the strata to which they are confined, and upon the effect of evaporation if in an open basin. In March, 1885, he had occasion to sink a well near Bryn Mawr, Pa. Natural anxiety as to the permanence of the supply led him to observe the depth of the water at intervals of about ten days. It soon became evident that the water was receding. In 1886 there was a gratifying rise of the surface and a total gain of 12 feet. His curiosity was aroused and he determined to study the law, if such a law existed, of this ebb and flow. These observations have been continued during the past seven years. He found that in normal years the surface of the water reaches its lowest level in December, rises until June, and descends during the autumn. An examination of the amount of the rainfall shows that while the amount of rainfall was as great or greater during the last half of the year as during the first, the level of the water in the well continually lowered. Atmospheric temperature had practically no effect, as the temperature of the water in the well is practically constant all the year round. The depth of the well prevented evaporation from its surface from having any effect. The author believes that the true cause is the result of the influences of gravity and of the sun's attraction at different seasons of the year. When the sun reaches its furthest point south of the equator, gravity exerts its maximum influence on the waters of the northern hemisphere. The waters of the earth will be drawn into the minutest crevices and the surfaces lowered, but in June they will, in a measure, be released, and, under the influence of adhesion and friction, will be held at a higher level than during any other season of the year. Data obtained from the Government records, showing the depth of water in the Great Lakes, show that there is a similar rise and fall, the range of yearly ebb and flow being from 12 to 15 inches in our northern lakes. So far as we are aware, no data exist for the small lakes. More extended research will, we believe, secure as complete a recognition of yearly tides as physical geography has always accorded to the phenomenon of daily tides. The author presented two diagrams, one of which showed the rise and fall of the water in the well covering a period of seven years, and also the northing and southing of the sun for the same period.

— In February, 1890, a grant was made by the Royal Society for the purpose of supplying the Ben Nevis Observatory with apparatus for counting the number of dust-particles in the air. Two instruments, one portable and another of larger dimensions, were made after designs by Mr. Aitken. With the latter observations may be made at any time, except when the wind, blowing from the south-west, pollutes the air above the inlet pipes with smoke from the observatory and hotel. Since February, 1891, observations have been made every third hour. Some of the results are given, and their bearing discussed, by Mr. Angus Rankin in the *Journal of the Scottish Meteor. Soc.*, Third Series, No. viii. It may be stated that a number of particles under 100 in a cubic centimeter of air is phenomenally small, and a number over 4,000 phenomenally large. The highest number was 14,400, which was counted in April, 1891. The particles are most numerous during March, April and May, when easterly and south-easterly winds are prevalent both at sea-level and on the summit of the mountain. On the other hand, when the winds on Ben Nevis blow from the north-west, north, or east, their directions diverge most from those of sea-level winds, and then the dust-particles are most scarce. Hourly observations were made only on four days, but the three-hourly means show the general trend of the daily curve. The means for the three months, March to May, show a minimum, 526, at 4 hours, and a maximum, 1,438, at 16 hours, the absolute mean for the three months being 854. The variations seem to be due to the movements of the first, or lowest, cloud stratum. In the morning this stratum lies below the summit of Ben Nevis, but towards noon rises and envelopes the top, hovers above it in the afternoon, and sinks to its original position about midnight. Several points remain to be cleared up. Apparently only the free dust-particles are counted, and few, if any, of those on which moisture has condensed to form visible fog; all the lowest values have been recorded when a thin mist enveloped the top. These observations will be of great service in the study of clouds—their forms, heights, and motions. The bearing of dust on the humidity of the air is also an important point; at present the humidity of the Ben Nevis atmosphere is very little understood.

— The papers entered to be read at the April meeting of the National Academy of Sciences were as follows: An American Maar, by G. K. Gilbert; The Form and Efficiency of the Iced Bar Base Apparatus of the United States Coast and Geodetic Survey, by R. S. Woodward (introduced by T. C. Mendenhall); On Atmospheric Radiation of Heat in Meteorology, by C. Abbe; On the Deflecting Forces that Produce the Diurnal Variation of the Normal Terrestrial Magnetic Field, by F. H. Bigelow (introduced by C. Abbe); Abstract of Results from the United States Coast and Geodetic Survey Magnetic Observatory at Los Angeles, Cal., 1882–1889, Part III., Differential Measures of the Horizontal Component of the Magnetic Force, by C. A. Schott; On the Anatomy and Systematic Position of the Mecoptera, by A. S. Packard; On the Laws of the Variation of Latitude, by S. C. Chandler; On the Causes of Variations of Period in the Variable Stars, by S. C. Chandler; On the Force of Gravity at Washington, by T. C. Mendenhall; On the Recent Variations of Latitude at Washington, by T. C. Mendenhall; On the Acoustic Properties of Aluminum, with Experimental Illustrations, by A. M. Mayer; Disruption of the Silver Haloid Molecule by Mechanical Force, by M. Carey Lea (introduced by G. F. Barker); On the Homologies of the Cranial Arches of the Reptilia, by E. D. Cope; On the Osteology of the Genus Anniella, by E. D. Cope; The Astronomical, Geodetic, and Electric Consequences of Tidal Strains within an Elastic Terrestrial Spheroid, by C. Abbe; Asiatic Influences in Europe, by E. S. Morse; Exhibition of Chladni's Acoustic Figures Transferred to Paper without Distortion, by A. M. Mayer; On Electrical Discharges Through Poor Vacua, and on Coronoidal Discharges, by M. I. Pupin (introduced by T. C. Mendenhall); Biographical Memoir of William

Ferrel, by C. Abbe; A Definition of Institutions, by J. W. Powell; Biographical Memoir of J. Homer Lane, by C. Abbe; The Partition of the North American Realm, by Theodore Gill; Exhibition of Teeth of a Gigantic Bear, Probably an Extinct Species, Found in Ancient Mounds in Ohio, by F. W. Putnam; A Means of Measuring the Difference Between the Tidal Change in the Direction of the Plumb Line and the Tidal Deflection of the Earth's Crust, A Posthumous Paper by J. Homer Lane, read by C. Abbe.

— Mr. Timothy Hopkins has made provision for the endowment and maintenance of the seaside laboratory at Pacific Grove, recently established under the auspices of the Leland Stanford Junior University. It is intended to make this a place for original investigation of the habits, life-history, structure and development of marine animals and plants and to carry on work here similar to that which is done at the acquarium at Naples. The Hopkins Laboratory will be under the general direction of Professors Gilbert, Jenkins, and Campbell. It will be open during the summer vacation, and its facilities will be at the disposal of persons wishing to carry on original investigations in biology, as well as of students and teachers interested in that line of subjects. It will be fully provided with aquaria, while microscopes, microtomes and other instruments necessary for investigations will be taken from the laboratories of the University.

— At a meeting of the Epidemiological Society (*Lancet*, Feb. 29, 1892) Dr. Pringle quoted a remarkable passage from an ancient Hindu work, which showed that true vaccination was known and practised in India centuries before the birth of Jenner: "The small-pox produced *from the udder of the cow* will be of the same mild nature as the original disease. . . . The pock should be of a good color, filled with a *clear* liquid, and surrounded by a circle of red. . . . There will be only slight fever of one, two, or three days, but no fear need be entertained of small-pox so long as life endures." Pasteur's attenuation of virus by successive cultures has been applied in India for hundreds of years to inoculations with variolous lymph, which the document in question directed to be taken from "the most favorable cases," and he has seen series of such selected inoculations in which there was no general eruption, and the local phenomena were scarcely distinguishable from those of vaccination.

— In a paper, in the April number of the *Botanical Gazette*, on "Some Fungi Common to Wild and Cultivated Plants," Byron D. Halsted, Rutgers College, New Brunswick, N.J., says: "It has been shown by means of a long series of examples that the evil influences of wild plants may act at long range. It is not necessary that their roots and those of the cultivated plants should cross each other's paths in the soil or that their branches should interlock and overshadow one another in a deadly embrace. There is a more subtle bad influence than gross thieving or clutching by the throat. It is more in the nature of a poison that is sent out upon the air to be breathed in by the innocent wherever they may unwittingly meet the unseen but deadly germs. Crowding of plants is bad, rank growth of weeds is worse, but the most fatal of all influences is that unseen group that steal away the health of the plants which lack nothing for room and enjoy high and thorough culture. After all it is the host of enemies that swarm from the plants outside the garden fence that try the patience of the husbandman. He has learned the methods of remedying the others, but the floating spores defy his keenest eyesight to discern and baffle his ingenuity to combat. The ways of the fungi are, however, being slowly and laboriously revealed by the microscope and conquered by the spraying pump. The former assists the latter, which as yet blindly fires effective "small shot" into the enemies' ranks. Proper seeding, fertilizing, and weeding will do much to assist in warding off the deleterious influences of fungous enemies; for healthy plants, while not proof against their attacks, are less liable to be overcome by them. Let therefore everything be done that is possible before the last resort comes and then the fungicide will have the greatest effect and yield the most returns. If so much of the smut, rust, mildew, mold, rot, and blight of our cultivated plants is propagated by the wild plants hard by, it may be wise for every crop-grower to pay attention to what is thriving outside his garden wall. He cannot build it high enough to shut out the spores, but he can do much to diminish the number of these spores. Having done this, he can take up the spraying pump with a brighter hope of future success. There was a carcass, so to speak, in the pasture and he went out and buried it. Fungi are the basis of contagion and they infect at long range by means of their myriads of invisible spores. To learn of their ways and find better methods of resisting them make the burden of many a station botanist's labor to-day."

— At the Washington meeting, Thursday, April 21, of the National Academy of Sciences Dr. Karl Barus, Professor Samuel F. Emmons and Mr. M. Carey Lea were elected members of the academy. Dr. Barus is connected with the United States geological survey, and is well known as a physicist. Professor Emmons is also connected with the geological survey and is a geologist. Mr. Lea is a Philadelphian, and is famous as a photographic chemist. The academy elected four foreign associate members. They were Professor Hugo Gylden of Upsala, Sweden; Professor Carl Weierstross of Berlin, Germany; Professor August Kekule of Bonn, Germany; and Professor E. Du Bois Reymond of Berlin, Germany.

— "On the Track of Columbus," a paper by Horatio J. Perry, is one of the features of the May *New England Magazine*.

— Professor N. S. Shaler, whose articles in *Scribner's*, on "The Surface of the Earth" and "Nature and Man in America," have done so much to make clear the practical features of geology and geography, begins in the May number of that periodical a group of four articles on Sea and Land, in which he will discuss Sea-Beaches, The Depths of the Sea, and Icebergs.

—Some time ago *Public Opinion*, the eclectic journal of Washington and New York, offered $300 in cash prizes for the best three essays on the question "What, if any, changes in existing plans are necessary to secure an equitable distribution of the burden of taxation for the support of the National, State, and Municipal Governments?" The competition has attracted much interest, and the committee, consisting of Hon. Josiah P. Quincy of Boston, Hon. Jno. A. Price, Chairman National Board of Trade, and Mr. W. H. Page, Editor of *The Forum*, have just awarded the first prize to Mr. Walter E. Weyl of Philadelphia; the second to Mr. Robert Luce, editor of *The Writer*, Boston; and the third to Mr. Bolton Hall of New York. The successful essays will be published in *Public Opinion* of April 23.

— "French Schools through American Eyes" is a report to the New York State Department of Public Instruction by J. Russell Parsons, Jr., the same gentleman who not long ago made a similar report on the German schools. Mr. Parsons remarks in his preface that "the belief that everything American is perfect constitutes a false form of patriotism which seems to be growing in this country;" but he maintains that in educational matters we have much to learn from foreigners. France, he thinks, has during the past twenty years made great advances in primary education, and now has some of the best public schools in the world. These schools he describes at considerable length, treating of their legal status and obligations, their organization, the method of selecting teachers, the methods of inspection, the courses of study, and many other aspects of the complex subject. His liberal use of statistics and the dryness of style characteristic of government publications make his book rather dull reading except to those especially interested in its theme; but to such persons it will convey much useful information. The most interesting part of it to the general reader is that which describes the courses of study in the various schools. The object sought by the French authorities is to teach those subjects that every person ought to know and to teach them in the most thorough manner possible. Moral education, too, receives special attention, and is so conducted as not to interfere in any way with the religious beliefs of either the children or their parents. Mr. Parsons gives tables showing the courses of instruction in several of the schools, which, however, we have not space to summarize. The book is published by C. W. Bardeen of Syracuse, N.Y.

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THE DETECTION OF ARTIFICIAL (IMITATION) GEMS.

IN most works on gems much stress is laid upon "hardness" as a means of distinguishing real from artificial "stones." Having had occasion during the past two years to examine several emeralds, rubies, etc., as to their genuineness, I have come to the conclusion that this property — which is, as everyone knows, of great assistance in the determination of uncut minerals — is of very little value in the examination of cut and polished gems, inasmuch as cutting a stone renders its surface much softer — in some cases reducing the hardness by over one-tenth — so that it can be "scratched" by minerals considerably lower in the scale of hardness than itself in its natural condition. On the other hand, many artificial gems will scratch ordinary window-glass quite readily, and have a hardness nearly equal to that of quartz, although it is popularly believed that if a "diamond" scratch glass it must be real.

Polishing the surface of a stone also necessarily affects its specific gravity, especially if the specimen be of small size, as is the case with most gems. Specific gravity as a means of detecting false gems is also rendered practically valueless by reason of the fact that special care is often taken in the manufacture of these articles to make them have specific gravities as nearly like the natural species which they are intended to imitate as possible.

Gems being usually much facetted, an examination of their optical properties becomes difficult and is of very little use in their practical determination.

Many gems are thought by their owners to be genuine on account of their having been in the possession of themselves or families as heirlooms for many years. Age in this case is no criterion as to value, as it is well known that the ancient Egyptians and Greeks were well versed in the manufacture of artificial stones.

The grand and really only reliable test, it seems to me, as to the genuineness or otherwise of a gem — in case we do not wish to totally destroy the specimen — is an examination of its fusibility. Artificial diamonds, emeralds, etc., if held in the border of the flame of a spirit-lamp or Bunsen burner soon become rounded on their edges, their fusibilities being generally considerably under three, according to von Kobell's scale of the fusibilities of minerals. The real stones, diamonds, etc., with the exception of the garnet, are practically infusible.

Great care should be taken in the examination of the fusibility of a gem, as, if the latter be genuine, it may, unless heated gradually and carefully, crack and fly to pieces on exposure to a high temperature. Moreover, some gems will change color if heated too highly. W. G. MILLER.

University of Toronto.

THE SYSTEMATIC POSITION OF THE DIPTERA.

HAVING been a student of the Diptera for two years, I have come to the conclusion that the order is entitled to the distinction of being, as a whole, more highly specialized than any other. Entomologists who have attempted a general classification of insects have almost uniformly regarded the Hymenoptera as the highest order, placing the Lepidoptera second, and the Diptera third. The only exception in America, I believe, is Professor Hyatt, who, in a recent book ("Insecta," by Alpheus Hyatt and J. N. Arms), has placed the Diptera at the head of the class, with the Hymenoptera second, and the Lepidoptera third. His argument for this arrangement is brief and forcible. The main features may be summarized as follows: —

The essential question which settles the rank of any insect is, How far does it deviate in structure, and through what line of descent has it developed, from its Thysanuriform ancestors? To introduce the subject of instinct or of usefulness to man is to confuse our ideas, for we cannot translate the data furnished by such a criterion into terms of the other standard. Applying this principle, he takes the following features of Diptera to show that they possess a degree of specialization surpassing any other order: —

1. Larval structure: "The young of even the generalized forms of Diptera are, as a whole, farther removed from the Thysanuriform type than those of any other group. The secondary larval form, which in the case of the Diptera is always footless and often an almost headless maggot, has complete possession of the younger stages. As Friedrich Brauer has pointed out, the general absence in the larvæ of Diptera of the thoracic legs, even although living in situations that seem to demand their development, shows that they must have inherited this peculiarity from an ancestral form whose larva had lost them. This comparative inflexibility of the larval stage is sufficient of itself to show that there is now a wide gap between the existing Diptera and all other orders of insects, and that this chasm is not closed by the resemblances of the parts in the adult to those of the Lepidoptera or isolated forms in other orders" (pp. 273, 274).

2. The presence of but two wings: "The tendency to the enlargement of one pair of wings, like the tendency to the enlargement of certain pairs of thoracic legs and the reduction of other pairs, or a change in their structure and function, so that the insect makes a departure from the conventional normal type of four equal membranous wings and six equal-jointed legs, is everywhere an index of specialization" (p. 274).

3. The mouth parts are developed for sucking only.

4. The attachment of the abdomen to the thorax in some flies shows that they once possessed a pedunculated abdomen, similar to that of Hymenoptera (p. 251).

Of these features, the first is the most weighty. Had not its importance been overlooked, the order could never have been thought inferior to the Lepidoptera, of which the members have while larvæ thoracic legs and usually abdominal ones also. Among the Hymenoptera, the Tenthredinidæ have thoracic legs and even more numerous abdominal ones than the Lepidoptera. The Uroceridæ also have rudimentary thoracic legs, although the larvæ are borers in wood.

The second and third arguments are essentially one in principle. In the lower winged insects, we find both pairs of wings of equal size and importance. The Hymenoptera show a condition in which the hind wings are much smaller and so of less use. Now, why do not the Diptera represent the extreme of this series? The question is not whether two pairs of wings or one pair are in themselves "higher;" it is rather, Which type shows the greater departure from the forms universally acknowledged as ancestral? So regarding the mouth development: If the mandibular mouth of Thysanura, Odonata, etc., be admitted as representing the ancestral form, then surely the mouth combining mandibular and suctorial apparatus is intermediate, and that with only suctorial organs is the ultimate degree of specialization. The recent researches of Dr. John B. Smith (Trans. Am. Ent. Soc., XVII.) show that true mandibles are almost never present in Diptera (he found them only in Simulium). Although his conclusions in this respect, as well as in regard to the homologies of the dipterous mouth in general, are widely different from those of earlier investigators, they are probably correct. In summing up, he says (p. 339), "The development required is simply a further development of the line started in the Hymenoptera."

An argument that strongly reinforces the first one above is found in the fact that the embryo in Diptera, at least in the higher forms, does not develop any traces of legs, differing in this respect from even the highest Hymenoptera, which first develop the legs and then reabsorb them before hatching (*Psyche*, June, 1891, p. 98).

The subject of mimicry also throws some light on these relations. As is well known, the Diptera afford many interesting cases of mimicry, and it is important to our theory to notice that they generally imitate the Hymenoptera, especially the very highest forms, such as wasps, humble-bees, and even honey-bees. One of the most widespread of all species, *Eristalis tenax* Linn., is such a good imitation of the honey-bee as to deceive the very elect. One of my students, an enthusiastic collector and well acquainted with this case of mimicry, once grasped a bee in his hand, under the impression that he was capturing one of these flies. Now, on any theory, we must admit that these species of flies are of more recent origin than the species which they mimic. Most of these imitative flies belong to the family Syrphidæ, which is considered to be one of the oldest of the group Cyclorrhapha, comprising the higher flies.

The Diptera, as a whole, are wonderfully rich in peculiar modifications of structure. In almost any organ the variety of forms exceeds that of any other order. Even the antennæ of beetles do not surpass, if they equal, those of flies in this respect. The wings are far more variable in venation than those of any other order. The variety and complexity of organs for grasping the female are almost beyond belief to one who has not seen them.

The one thing which has prevented the recognition of the real rank of the Diptera is a lingering notion that specialization by reduction really brings an insect down to a lower position in the scale. The word "high" suggests the idea of "complete," or "perfect," or "typical." If Professor Hyatt's test were to exclude every other, as it ought to, there could scarcely be any further disagreement on the question of the highest order.

The line of argument here suggested points to the Pupipara as the highest of all insects; nor would I in the least seek to evade the conclusion. Of the group, I have seen only the Hippoboscidæ; among these the sheep tick, *Melophagus ovinus* Linn, appears to deserve the highest rank.

J. M. ALDRICH.

DEBLOOMING MINERAL OILS.

It is a common practice with dealers in mineral lubricating oils and what are known as wool-stock and neutral oils to add certain chemicals to these oils to destroy the bluish fluorescence or "bloom." The bloom on ordinary refined kerosene is very noticeable, while paraffin oil, i.e., oil that has been distilled from petroleum tar, or residuum, is intensely blue. A good way to see the bloom of an oil is to view it through the ordinary four-ounce sample bottle. These bottles are made with straight sides and of white glass. A test-tube answers very well. The bottle should be held in front of a window and viewed through the bottom.

If a drop of oil be put on a piece of black glass, or on a piece of window-glass painted black on the bottom, the bloom will show even when the oil appears bloomless in the bottle. The bloom of oils may be destroyed or masked by nitric acid, nitro-benzol, di-nitro-naphthalene, and some other nitro-compounds. The use of nitric acid, of course, destroys the oil for lubricating purposes.

The di-nitro-naphthalene of commerce is a very efficient deblooming agent. I found, however, that if this material be washed in hot water until the free acid and free nitrobenzol (?) be washed out, it loses its deblooming properties.

A small percentage of oil of myrbane added to wool-oil or neutral oil will destroy or mask the bloom altogether. At the same time it, like the di-nitro-naphthalene, darkens the oil, and gives it the odor of benzol.

The usual practice is to add a quantity of di-nitro-naphthalene to a portion of the oil to be treated, warming it gently meanwhile, and then, when the oil is about to be sold, to add this strong solution to the bulk of the oil. This is done because the nitro compound is liable to crystallize out in the cold, and also to stain yellow the containing vessel and to darken the oil on standing.

If a bright piece of steel be put into oil containing much di-nitro-naphthalene the steel becomes corroded. It will be readily seen that such oil is unfit for lubricating purposes. If the oil be filtered while cold, fine crystals of di-nitro-naphthalene will collect on the filter, and at the same time the filter is stained yellow. The bloom reappears in the filtered oil, showing that the bloom was only covered up and not destroyed.

The only safe and proper way to bleach and debloom oil is to expose it to the sun and air for a long time — two or three weeks or so — depending on the weather. By this method no deleterious substances are added to the oil, while at the same time it is rendered sweeter in odor and the "body" is somewhat increased. The bleacher consists of a shallow tank, sometimes covered with glass, but more generally exposed to the sun and rain. Into these tanks a few

inches of water is run, and on top of this the oil. Any impurities settle to the bottom of the water, and are left when the oil is drawn off. In some of the larger refineries these bleachers literally cover acres of ground. The great objection to this method of bleaching is the length of time occupied and the immense space taken up by the bleachers.

It may be asked, What is the object of deblooming oils? So far as I can learn the only object is that they may be used to adulterate the more expensive animal and vegetable oils, such as lard, tallow, linseed, and cottonseed oils.

A mixture of lard oil, 75 per cent at 50 cents a gallon, and debloomed neutral oil, 25 per cent at 13 cents a gallon, will pass for pure lard-oil with anyone but an expert. This fraud may be detected by the lower flashing and burning points of the mixture and by the change in specific gravity from that of pure lard oil. The tests mentioned above may also be applied. D. T. MARSHALL.

Boston, Mass., April 21.

ASTRONOMICAL NOTES.

[*Edited by George A. Hill.*]

Winnecke's Periodic Comet.

IN No. 3,083 of the *Astronomische Nachrichten* Dr. Haerdtl of Vienna publishes corrected elements for Winnecke's periodic comet, and also an ephemeris extending into next September. The comet will reach perihelion on July 1, be the nearest to the earth on July 9, when it will be only 11 million miles from the earth and attain a brightness 140 times that it had when found by Dr. Spetalerou March 18 last. The comet at the date of discovery was 72 million miles from the earth. The epoch of the ephemeris is for Berlin midnight.

	R.A.			Dec.		
	h	m	s		°	′
April 30	11	34	23	+	44	2
May 1		32	42		44	8
2		31	4		44	13
3		29	27		44	18
4		27	52		44	22
5		26	20		44	26
6		24	49		44	29
7		23	11		44	31
8		21	52		44	33
9		20	27		44	34
10		19	3		44	35
11		17	41		44	36
12		16	21		44	36
13		15	3		44	35
14		13	46		44	34
15		12	13		44	33
16	11	11	16	+	44	31

Comet Swift.

The following is a continuation of the ephemeris for comet Swift. This comet may prove to be a very interesting one, as the computations made seem to point to the fact that it is moving in a hyperbolic orbit. The observations at the present time do not extend over a sufficient interval to be absolutely sure of this statement, but as the comet is a bright one, it will probably give us a long series, when the question can be definitely settled. We have so few positive cases of comets moving in hyperbolic orbits that this one will receive at the hands of computers a very thorough discussion. The Rev. G. M. Searle, director of the Observatory of the Catholic University at Washington, has computed both hyperbolic and parabolic orbits for this comet. The difference between computation and observation for the middle places in the hyperbolic orbit is zero, while in the parabolic orbit it is $+ 15''$ in longitude and $+ 7''$ in latitude. The following is a continuation of the ephemeris published in No. 481 of *Science*.

	R.A.			Dec.		
	h	m	s		°	
May 8	22	53	10	+	25	28
9		55	58		26	6
10	22	58	45		26	42
11	23	1	30		27	18
12		4	13		27	53
13		6	55		28	28
14		9	35		29	2
15		12	14		29	35
16		14	51		30	7
17		17	27		30	39
18	23	20	1	+	31	11

Comet Denning.

The following is an ephemeris for comet Denning. The epoch is for Berlin midnight:

	B.A.			Dec.		
	h	m	s		°	
May 8	3	11	48	+	55	11
9		15	23		54	57
10		18	54		54	42
11		22	22		54	27
12		25	46		54	12
13		29	7		53	57
14		32	24		53	42
15		35	38		53	27
16		38	48		53	12
17		41	55		52	57
18	3	44	58	+	52	41

MR. PETRIE'S DISCOVERIES AT TEL-EL-AMARNA.

ONLY recently the news reached us of the discovery by the Direction of Exploration in Egypt of the tomb of King Amenhotep IV. (Khu-n-aten) at Tel-el-Amarna; and now, from another quarter, we hear of further important discoveries in the same locality.

The labors of Mr. W. M. Flinders Petrie, who has been working all winter at the excavation of the royal palace of Khu-n-aten, have been rewarded by a most unexpected find, one, indeed, that is unparalleled in the history of archæology. Lying on the ground, tossed in a corner among spoilt blocks of rough granite "Ushabtis," discarded by the artisans who had prepared the king's sepulchral furniture, lay the plaster cast, the mask, of the dead man himself, evidently taken immediately after his death by the sculptors employed to carve his statues. It is in an almost perfect state of preservation.

This extraordinary relic of one of the most interesting figures of antiquity lends unforseen support to the view of the monarch's character suggested in my last article. According to Mr. Petrie, the face thus revealed, as it were, in the flesh, "is full of character. There is no trace of passion in it, but a philosophical calm, with great obstinacy and im-

practicability. He was no fanatic, but rather a high-bred theorist and reformer" How vividly clear do such facts as these make the remote past appear; and what deep meaning they lend to the words of that greatest of word-painters, Ernest Renan: "A giant even placed on the confines of a picture still remains a giant."

The palace has been exhumed and the pavements — beautifully frescoed with tanks and fishes, birds and lotus plants, and almost unique in their style — have come to light; also inlaid walls and splendid columns inscribed with scenes and capped wilh capitals imitating "gigantic jewelry." Their surface was encrusted with brilliant glazes, and the ridges between these were gilt, so that they resembled gems set in gold, the effect thus produced reminding the explorers of the "net-work" of the "Temple of Solomon."

Mr. Petrie was also fortunate enough to come across smaller objects, which have thrown light upon the history of the period. In a neighboring quarry he found the name of Queen Thii, the mother of Khu-n-aten, unaccompanied by that of a king. This fact has given him good ground for the suggestion that she may have governed alone during the minority of her son, who, to all appearances, was only married in the fifth year of his reign, his first child having been born in his sixth year. In the fifth year of his reign the king was still called Amenhotep, as shown in a papyrus found at Gurob, but in his sixth year he appears at Tel-el-amarna as Khu-n-aten; so that the great schism which led to the final rupture between himself and the Theban priesthood must have occurred between those two dates.

Moreover, Mr. Petrie has in his possession a scarab on which Amenhotep is represented in adoration before Aten, the name of Amen having been subsequently erased. This scarab finally settles the question, so often raised, of the identity of the man who bore both names.

Relics of the successors of Khu-n-aten — Ra-Saa-Ka-Khepru, Tut-Ankh-Amen, Aï — were also recovered at Tel-el-amarna, showing them to have resided there after him; and even Hor-em-heb left a block of sculpture inscribed with his "cartouche" in the temple of Aten, probably in the early part of his reign and before his compromise with the conservative Theban party. After that time the site was apparently abandoned and no traces remain of further occupation.

The cuneiform tablets discovered in 1887 were all in store-rooms outside the palace, near the house of the Babylonian scribe, which Mr. Petrie identified by finding the "waste pieces of his spoilt tablets in rubbish holes."

A large quantity of Ægean pottery similar to the Mykenæ and Ialysos type was found, of even greater variety of form than that recovered at Gurob. And this as well as the naturalistic character of the frescoes, which Mr. Petrie compares with those of Tiryns and with the gold cups of Vaphio, and the geometrical patterns that decorate some of the columns, which in his opinion closely approach the art of the Mykenæ period, are highly suggestive of Greek intercourse and influence.

The court of Khu-n-aten, in the fifteenth century B.C., must have been a remarkable one. Under the quickening influence of a great mind the foreign conquests of the warlike monarchs of the eighteenth dynasty seem to have been made to yield the richest fruits of peace. A wide-spread intercourse had been established among nations; Phœnicians, Syrians and Mesopotamians, Greeks and Mediterranean Islanders are revealed to us as having come into the Nile valley, bringing along with their commerce their arts, their industries, and various indirect influences. No wonder that the priests of Amon saw with dread and aversion the influx of foreigners who, encouraged by the evident cosmopolitanism of their king, bid fair to revolutionize the ancient traditions of their venerable land and to remove the narrow boundaries of Egyptian conservatism. S. Y. STEVENSON.

THE ROLLING OF SHIPS.[1]

ONE fact that often strikes the thoughtful traveller by sea is that, notwithstanding the great and numerous improvements of recent years which have made life on shipboard pleasant and luxurious, little or nothing has been done to steady a vessel when she meets with waves that set her rolling heavily from side to side. The tendency seems to be rather in the direction of increased than of diminished rolling; for the steadying influence of sails, which makes the motion so easy and agreeable in a sailing ship, is fast disappearing in large steamers. Masts and sails add appreciably to the resistance of large fast steamers; so they have been cut down in size year by year till such fragments of sail as still remain are so small compared with the size of the ship as to retain little power to reduce rolling.

Shipowners and seamen do not show much sympathy with the discomfort and misery that rolling causes to most passengers. They perhaps get anxious about an occasional vessel that acquires the evil reputation of being a bad roller, because passengers may be frightened away and the receipts fall off in consequence; but beyond wishing, or attempting, to deal with abnormal cases, nothing seems to be thought of. Rolling is considered incurable, or as not of sufficient importance to trouble about. Yet there is nothing which would contribute so directly to the comfort of landsmen at sea, or do so much to change what is for many misery and torture into comfort, as to check and reduce as far as possible the rolling proclivities of ships.

The laws which govern rolling are now well understood, and it is strange that this knowledge has not enabled an effective means of control to be devised. What is stranger still is that well-known means of mitigating rolling — such as the use of bilge keels — are employed in but very few cases. A ship rolls about a longitudinal axis which is approximately at her centre of gravity, and the rolling is practically isochronous at moderate angles in ordinary ships. The heaviest rolling occurs when the wave-period synchronizes with the natural period of oscillation of the ship. Many vessels are comparatively free from rolling till they meet waves of this period, and if such meeting could be avoided, excessive rolling could be prevented. Some vessels have periods as long as fifteen to eighteen seconds for the double oscillation, and as these would require to meet with waves 1,300 to 1,500 feet in length, in order to furnish the conditions of synchronism, it is seldom that they suffer from heavy or cumulative rolling. Such waves are, however, not rare in the Atlantic.

The limits of heavy rolling are fixed, of course, by the resistance offered by the water and air to the transverse rotation of the ship, which is very great because of the large areas that directly oppose motion in a transverse direction. But for this resistance, and the condition that rolling is only isochronous within moderate angles of inclination, a few waves of the same period as that of a ship would capsize her.

[1] From Nature.

The two most obvious modes of preventing heavy rolling are, therefore, (1) to make the period of rolling of a ship as long as possible, so as to reduce the chances of meeting waves whose period will synchronize with it, and (2) to increase the resistance to rolling. The period of a ship varies directly as her radius of gyration, and inversely as the square root of her metacentric height. Hence the period may be increased by increasing the moment of inertia of the ship, or by decreasing the metacentric height. In armored war-vessels the moment of inertia is large, on account of the heavy weights of armor on the sides, and the heavy guns that are either placed at the side or high up above the centre of gravity. Ordinary steamers have no such weights concentrated at great distances from the centre of gravity, and their moments of inertia are determined by the distribution of material in the hull that is fixed by structural conditions and by the stowage required for their voyages. Metacentric height cannot be reduced below a certain amount, which is necessary to prevent too easy inclination of the ship, or crankness, in still water. On the whole, we may regard the longest periods that the largest ships are likely to have with advantage to be about those named above, i.e., fifteen to eighteen seconds.

Length of period cannot give immunity against occasional heavy rolling; but increase of resistance reduces the angles of roll at all times, and especially when the angular velocity is greatest and the rolling is worst. Such resistance is furnished by the frictional resistance of the bottom of a ship and by the direct resistance of projecting parts of the bottom, such as the keel and the large flat surfaces below at the stem and stern. This resistance can be largely increased by means of bilge keels. The value of bilge keels is recognized in the Royal Navy, and the ships of the navy have been fitted with them for many years with highly beneficial results. The advantage of bilge keels was proved beyond all doubt many years ago by careful experiments made in this country and in France; and the late Mr. Wm. Froude showed, by the trials he made of H.M.S. "Greyhound" twenty years ago, that bilge keels of excessive size — 3 feet six inches deep, and 100 feet in length, on a vessel 172 feet long — had only an insignificant effect upon speed throughout great differences of trim.

It is strange that the mercantile marine should not yet have adopted bilge keels, and obtained the undoubted advantage they give in steadiness. The number of ships that have them is comparatively few. There is an almost universal opinion and prejudice against their use, and the largest and finest passenger steamers have no bilge keels. This is in spite of the fact that, in cases where bilge keels have been fitted to try to check heavy rolling — and they have been of suitable size and properly placed — it has been found that the angles of rolling have been reduced by nearly one-half. There is a prevalent belief — which has no foundation in fact — that bilge keels are very detrimental to speed. We have said that Mr. Froude's experiments showed the contrary, even on trials made in still water; but it appears certain that at sea any trifling loss of speed which still-water trials might show would be more than compensated for by gain in speed when the vessel is prevented from rolling through large angles from side to side, and undergoing great changes of underwater form at every roll. Experience with ships that have had bilge keels added after running for some time without them shows that there has been no appreciable difference of speed or increase of coal consumption on their voyages.

Another, and a more heroic, method of stopping or reducing rolling would be to counteract the inclining moment of the ship caused by the ever-changing inclination of the waves by an equal and opposite moment, which would vary as the inclining moment varies. This has been attempted at different times and in various ways. It is essential to any degree of success, however, that the opposing moment brought into operation should be completely under control, so as always to act in the manner and to the extent required. The attempts to obtain a steady platform by freely suspending it, and making it independent of the rolling of the ship, have failed — apart from the practical difficulties of carrying out such an arrangement on a large scale — because the point of suspension oscillates when the ship rolls, and the platform acquires a rolling motion of its own. Weights, made of heavy solid material, which move from one side to the other of a ship subject to the action of gravity and rotation, fail because they cannot be made to act continuously in the manner required.

A degree of success has been achieved by admitting water into a suitably prepared chamber and leaving it free to move from side to side as the ship rolls. This has been done in several ships of the navy, the case of the "Inflexible" being that which was the most carefully experimented upon. The movement of this internal water follows the inclination of the ship, but it lags behind, and thus tends to reduce the inclination. Its effect can be regulated by the quantity of water admitted into the chamber and by its depth. The "Inflexible" committee state in their report that comparatively small changes in depth increase or diminish largely the extinctive power of the water. For various reasons — one of which is that while such a chamber is very effective in a moderate sea it fails in a rough sea when the rolling of the ship is greatest — and perhaps partly on account of the destructive and disturbing effect of 100 tons or more of water rushing from side to side of a ship over sixty feet wide — these water-chambers appear to have gone out of use in the navy, and they have been given up in the "City of New York" and "City of Paris," which vessels were said to be fitted with them when first built and placed upon the Atlantic.

Mr. Thornycroft has devised a means of checking rolling by moving a weight, under strict control, from side to side of a vessel so as to continuously balance, or subtract from, the heeling moment of the wave-slope. It consists of a large mass of iron in the form of a quadrant of a circle, which is placed horizontally, with the centre on the middle line of the vessel, and there connected with a vertical shaft. The shaft is turned by an hydraulic engine, which is very ingeniously controlled by an automatic arrangement. The heavy iron quadrant is swept round from side to side, revolving about its centre, to the extent that is required to counteract the heeling moment. In a paper read on the 6th instant before the Institution of Naval Architects, Mr. Thornycroft said: —

"The manner in which the controlling gear works will be better understood if we imagine a vessel remaining upright among waves, while near the centre of gravity of the ship we place a short-period pendulum suspended so as to move with little friction; this will follow the change in the apparent direction of gravity without appreciable loss of time, so that any change in the wave-angle and apparent direction of gravity cannot take place without due warning, which will indicate the time and amount of the disturbance. It is therefore only necessary to make the motion of the

ballast bear some particular and constant ratio to the motion of this short-period pendulum to keep the balance true. The inertia of a heavy mass will cause some loss of time, as we can only use a limited force for its control; but it is possible to accelerate the phase of motion and overcome this difficulty so far as to get good results.

"If, now, we imagine the ship to roll in still water, the effect of the combination just described will be to balance the ship's stability for a limited angle; but this defect is removed by the introduction of a second pendulum of long period, which tends to move the ballast in the opposite direction to the first one, and enables the apparatus to discriminate between the angular motion of the water and that of the vessel.

"I find, however, that the long-period pendulum is rather a delicate instrument, and that its function can be served by a cataract arranged so as to always slowly return the ballast to the centre, and this device has the effect of accelerating the phase of motion, which, in some cases, we also require.

"We are therefore able, by very simple parts, to construct an apparatus which will indicate the direction and amount of motion necessary to be given to the ballast at a particular time so as to resist the wave effort; this power of indicating may be converted into one of controlling by suitable mechanism. The loss of time due to inertia of the necessary ballast is not always unfavorable when the apparatus has to extinguish rolling motion, the greatest effect being obtained when the ballast crosses the centre line of the ship at a time when it is most inclined to the water surface, and this corresponds to a quarter of the phase behind the motion of the short pendulum."

The apparatus has been working for some time in the steam yacht "Cecile" with very good results. What the objections may be to applying it to the largest passenger steamers remains to be seen. A moving weight of something like 100 or 150 tons would probably be required in such vessels. The power necessary to control the movement of the weight appears to be small, and Mr. Thornycroft's invention seems at any rate to show the way towards obtaining the long-desired boon of substantially reducing, if not checking altogether, the rolling of ships. If it succeed in doing upon a large scale only a portion of what is claimed for it in the way of anticipating and counteracting the heeling effect of waves, without the possibility of acting in an erratic or undesirable way, we may hope to see it adopted some day in passenger steamers.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

A Fire-Ball.

A TELEPHONE wire was supported on cedar posts 20 feet high and 20 rods apart. During last August [1889] we had a thunderstorm, during which there was a sharp and heavy crash. Several of the poles were found to have been struck, and portions to have been taken out through their entire length. One of these portions, of the size of a medium rail, was thrown into an adjoining field some rods from the pole. Portions from the others were smaller and more or less shattered. Near the southernmost pole struck, a family were in a house with doors and windows open, and a luminous ball seemed to leap from the wire, pass through the open door and a window, and pursue its course some rods through the open space behind the house. A boy in the room grasped his thumb and cried out, "I'm struck," and Mr. Hewett felt a sensation of numbness in his left arm for some time. A girl seized her shawl and rushed out of the house to chase the ball. She reported that she pursued it some distance, while it bounded lightly along, until it seemed to be dissipated in the air without an explosion. The size of the ball was about that of the two fists, and its velocity about that of a ball thrown by the hand.

C. C. BAYLEY.

Lightning.

THE account of a stroke of lightning in *Science* for Jan. 29 last and the article in the issue of April 8 on "The New Method of Protecting Buildings from Lightning" call attention to a subject which has been greatly neglected, viz., the nature, characteristics, and effects of lightning strokes. Besides the passage of the electricity from the cloud to the earth, or the reverse, heavy discharges are always accompanied by other phenomena, which vary on different occasions, and which, for want of record and tabulation, have not yet been explained and their laws determined. In the loose accounts given of them in our daily journals they are spoken of as "freaks of lightning," and no further notice is taken of them. In the hope of doing something towards making a careful record, I offer the following, which has never been published.

The village of Amherst, Mass., is supplied with water from a reservoir among the Pelham hills, about five miles distant. The aqueduct runs nearly in a straight line from east to west. The pipes are made of thick sheet-iron bent into tubes, and the overlapping edges are riveted together with copper rivets about two inches apart. They are covered both without and within with a thick coat of cement. The joints are filled with cement so that the irons do not come in contact, an iron ring five or six inches broad is slipped over the joint, and the whole covered with cement. At a place about half a mile west of the reservoir the aqueduct runs near the foot of a steep hill that is seventy or eighty feet high and covered with a recent growth of white pine, shrub oaks, and yellow birch from ten to thirty feet in height, the intervals of the trees being filled with bushes. During a very heavy shower in July, 1884, a thunder-bolt was seen to fall on the hill. It struck a pine tree half-way down the side of the hill, whose top, on a horizontal line, was not more than two rods from the bottom of the trees on the summit. The tree struck was about twenty-five feet high and eight inches in diameter at the butt. The lightning did not apparently strike it on the top, but about one-fourth of its height from the top, at three equidistant points on the circumference the bark began to be ruptured, and the ruptures continued in straight lines to the ground. There the three currents united, ran over the ground, scattering the dirt and leaves in all directions for two rods, until it came over the aqueduct. There it bored a hole an inch in diameter down to the pipes. It struck about the middle of one of the lengths, broke the cement, and indented the iron as with a heavy blow of a sledge-hammer. The surface of the indentation appeared to have been melted. The current then turned to the west, ran along the top of the pipes, which were full of water under heavy pressure, stripped off the cement and slit the iron tubes through the whole, or a part, of their length. When a line of rivets came in its path, it cut them off between the overlapping edges of the iron as smoothly as with a knife, leaving the parts in each edge undisturbed. At the joints it rent off rings and cement, and indented the edge facing the current, melting the surface as in the place where it first struck the pipe. Rarely was the edge from which the current flowed indented. These effects continued for more than a mile, growing less and less, and finally disappeared.

Several questions in this connection require solution.

1. If the discharge is simply the equalizing of the potential between the cloud and the earth, why was that not accomplished as

soon as the current reached the ground, the wet earth being a good conductor?

2. Why did not the lightning strike the trees on the summit rather than one several feet below, and why not the top of the latter?

3. Why did it indent the pipes, and why the edges facing the current rather than the other? Is electricity material? Can anything not material manifest such a *vis viva* or working energy? Why was the iron melted when electricity has no inherent heat?

4. Do not the effects at the junctions of the pipes indicate a sort of damming up of the current by the cement until the pressure became sufficient to burst the barrier, and then it struck the following edge with its accumulated flood?

MARSHALL HENSHAW.

Amherst, Mass., Apr. 21.

[The phenomena presented in lightning strokes have heretofore appeared so lawless that it may be well to call attention to the fact, which has been repeatedly observed, that but little damage is generally done to portions of trees on the same levels as the foliage. It has also been observed that the presence on any level of a conductor of considerable surface, and consequent large electrical capacity, mitigates the effects on that level. Whether the large conducting surface presented by the wet leaves of a tree is a parallel case is, of course, a question; but the fact as stated is among those well authenticated in regard to lightning effects.—ED.]

Periodicity of the Aurora.

ON Saturday night, April 23, there was a fine Aurora seen in this locality whenever the clouds broke away until after midnight. This display is specially interesting because it is the sixth consecutive return of an aurora at the precise interval of twenty-seven days, the dates being as follows: Dec. 9, Jan. 5, Feb. 2, Feb. 29, March 27, and April 23. The display will be due again upon May 20. It has been associated with reappearances at the sun's eastern limb of an area south of the equator which has been much frequented by spots and faculæ. In like manner a record now before me shows that reappearances at the eastern limb of disturbed areas in the sun's northern hemisphere have their chief magnetic effect during the autumn months. From this it would seem that in order that a solar disturbance may affect the earth's magnetism it must be in a particular location, namely, at the eastern limb and as near as possible to the plane of the earth's orbit. Certainly such disturbances do not have their magnetic effect promiscuously in all locations, or at present we should have auroras and magnetic storms continuously, which is very far from being the case.

M. A. VEEDER.

Lyons, N.Y., April 25.

CALENDAR OF SOCIETIES.

Philosophical Society, Washington.

April 23.—G. M. Searle, On a Simple Form of Double-Image Micrometer; Arthur Keith, The Geology of Chilhowee Mountain in Tennessee; B. E. Fernow, Timber Physics.

Chemical Society, Washington.

April 14.—Wm. H. Krug, On Behavior of Acetone and Carbo-Hydrates; F. W. Clarke, On the Decomposition of Certain Silicates by Heat; Thomas Taylor, Smokeless Powder.

Publications Received at Editor's Office.

BRYANT, WILLIAM C. Sella, Thanatopsis and other Poems. Boston, Houghton, Mifflin & Co. 16°, paper. 95 p. 15 cts.
GORE, J. HOWARD. A German Science Reader. Boston, D. C. Heath & Co. 12°. 196 p. 80 cts.
MILLER, OLIVE THORNE. Little Brothers of the Air. Boston, Houghton, Mifflin & Co. 12°. 271 p. $1.25.
POSSE, NILS. Handbook of School Gymnastics of the Swedish System. Boston, Lee & Shepard. 18°. 192 p. 50 cts.
WEED, CLARENCE M. Spraying Crops. New York, Rural Pub. Co. 16°. 110 p. Ill.

Exchanges.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 874 Broadway, New York.]

For sale or exchange, Das Ausland, 10 vols., 1882 to 1891, including 6 vols. bound, 4 in numbers. Wheeler Survey, vol. 1, Geog. Report; also vol. 6, Botany; Production of gold and silver in the United States, 1880, '1, '2, '3, '5; Selfridge Isthmus of Darien. Will sell at very low prices. J. F. James, 1443 Corcoran St., Washington, D. C.

For exchange.—A fine thirteen-keyed flute in leather covered case, for a photograph camera suitable for making lantern slides. Flute cost $27, and is nearly new. U. O. COX, Mankato, Minn.

To exchange; Experiment Station bulletins and reports for bulletins and reports not in my file. I will send list of what I have for exchange. P. H. ROLFS, Lake City, Florida.

Finished specimens of all colors of Vermont marble for fine fossils or crystals. Will be given only for valuable specimens because of the cost of polishing. GEO. W. PERRY, State Geologist, Rutland, Vt.

For exchange.—Three copies of "American State Papers Bearing on Sunday Legislation," 1891, $2.50, new and unused, for "The Sabbath," by Harmon Kingsbury, 1840; "The Sabbath," by A. A. Phelps, 1842; "History of the Institution of the Sabbath Day, Its Uses and Abuses," by W. L. Fisher, 1859; "Humorous Phases of the Law," by Irving Browne; or other works amounting to value of books exchanged, on the question of governmental legislation in reference to religion, personal liberty, etc. If preferred, I will sell "American State Papers," and buy other books on the subject. WILLIAM ADDISON BLAKELY, Chicago, Ill.

Wanted, in exchange for the following works, any standard works on Surgery and on Diseases of Children: Wilson's "American Ornithology," 3 vols.; Coues' "Birds of the Northwest" and "Birds of the Colorado Valley," 2 vols.; Minot's "Land and Game Birds of New England;" Samuels' "Our Northern and Eastern Birds;" all the Reports on the Birds of the Pacific R. R. Survey, bound in 2 vols., morocco; and a complete set of the Reports of the Arkansas Geological Survey. Please give editions and dates in corresponding. R. ELLSWORTH CALL, High School, Des Moines, Iowa.

To exchange Wright's "Ice Age in North America" and Le Conte's "Elements of Geology" (Copyright 1882) for "Darwinism," by A. R. Wallace, "Origin of Species," by Darwin, "Descent of Man," by Darwin, "Man's Place in Nature," Huxley, "Mental Evolution in Animals," by Romanes, "Pre-Adamites," by Winchell. No books wanted except latest editions, and books in good condition. C. S. Brown, Jr., Vanderbilt University, Nashville, Tenn.

For Sale or Exchange for books a complete private chemical laboratory outfit. Includes large Becker balance (200g. to 1-10mg.), platinum dishes and crucibles, agate motors, glass-blowing apparatus, etc. For sale in part or whole. Also complete file of *Silliman's Journal*, 1862-1885 (62-71 bound); Smithsonian Reports, 1854-1883; U. S. Coast Survey, 1854-1869. Full particulars to enquirers. F. GARDINER, JR., Pomfret, Conn.

Wants.

Any person seeking a position for which he is qualified by his scientific attainments, or any person seeking some one to fill a position of this character, be it that of a teacher of science, chemist, draughtsman, or what not, can have the 'Want' inserted under this head at 10 cents a count line. Nothing inserted at less than 50 cents a time prepaid by stamps, if most convenient.

TRANSLATOR wanted to read German architectural works at sight (no writing). One familiar with technical terms desired. Address "A.," Box 149, New York Post Office.

WANTED.—A position in a manufacturing establishment by a manufacturing Chemist of inventive ability. Address M. W. B, care of *Science*, 874 Broadway, N. Y.

WANTED.—Books on Anatomy and Hypnotism. Will pay cash or give similar books in exchange. Also want medical battery and photo outfit. DR. ANDERSON, 182 State street, Chicago, Ill.

WANTED.—A college graduate with some normal training, to teach the sciences, at $1,800 per year, in a Southern college. A Baptist or a Methodist preferred. Must also be a first-class Latin scholar. A. H. Beals, Box K, Milledgeville, Ga.

A PROFESSORSHIP in Chemistry is wanted by one who has had five years' experience in that capacity. Would prefer to give instruction by lectures and experiments rather than by text-book methods. Would like a position in a college or university where there is a good student's laboratory. Special points of strength claimed are: (1) Thorough control of a class and good order during lectures and recitations. (2) Accuracy in experimenting with chemicals and skill in the manipulation of chemical apparatus. The permission of several distinguished educators has been given to refer to them if required. Would not care to accept a position paying less than $1,500. Address B. E., care of *Science*, Advertising Dept., 47 Lafayette Place, New York.

ADDRESS WANTED.—Will some one please send the address of the Secretary of the American Philological Society. Also that of Herbert Spencer. "ADDISON," Room 84, 164 Madison St., Chicago, Ill.

ADDRESSES of Old Book Dealers wanted.—Wishing to obtain a number of old books out of print, I very much desire the addresses or catalogues of rare second-hand book dealers. If there is a directory or list of such dealers I should like to obtain possession of one. W. A. BLAKELY, Chicago, Ill.

WANTED.—(1) A white man versed in wood and iron working, able to work from specifications and plans, suited for an instructor of boys; his business to have charge of shops of school, outline and direct the work for foremen and students; salary to be $1,000 per annum (nine months). (2) A man (black preferred) to teach the colored, iron working and forging, subordinate to the preceding; salary, $720. (3) A man (white) competent to take classes in engineering (assistant's position), but with the ability to perform any of the work required in any of the ordinary engineering courses of our universities; salary from $1,000 to $1,500. A. H. BEALS, Milledgeville, Ga.

AMONG THE PUBLISHERS.

Babyhood continues in its May issue the medical articles on catarrhal affections and their complications in children, and the treatment of the headaches of childhood.

— The recent discussion over Jewish immigration to this country imparts a timely interest to Mr. Joseph Pennell's volume entitled "The Jew at Home." This artist has visited and studied the Jewish towns of the Austro-Hungarian Empire, and the results of his observations will be found both in his text and in a series of illustrations. "The Jew at Home" will be published immediately by D. Appleton & Co.

— *The Chautauquan* for May presents the following among other articles: "Physical Culture," IV., by J. M. Buckley, LL.D.; "The United States Patent Office," Part I., by Helen Frances Shedd; "The Natural History of Plants," II., by Gerald McCarthy; "Flower Shows in the United States," by Samuel A. Wood; "Phrenology," by Garrett P. Serviss.

— In *Lippincott's Magazine* for May, Mr. Floyd B. Wilson has a paper on "Personal Economics in our Colleges," and Mr. Philemon Hemsley, in "After-Dinner Botany," traces the relationship between certain edible and other plants not usually connected in our thoughts.

— Professor Jowett's translation of "The Dialogues of Plato," the second edition of which has been for several years out of print, will appear in May in the third edition, forming five 8vo volumes. The work has been revised and corrected throughout and in great part rewritten. Macmillan & Co, the publishers, have copyrighted the new edition by resetting the entire work in this country.